THE CORRELATION OF YIELD AND SPECIFIC GRAVITY IN THE USDA POTATO BREEDING PROGRAM

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Abstract

Every year potato (*Solanum tuberosum* L.) clones which remain in the USDA potato breeding program after six or more years of selection are entered into yield trials in Maine. Specific gravity and yield data were analyzed for six years (1972, 1975, 1978, 1981, 1984, and 1987) to determine the relationship between specific gravity and yield for populations of white and russet potatoes. In these trials, marketable yields of white-skinned potatoes were significantly greater than those of russet potatoes. Average specific gravity was significantly greater in the white than in the russet potatoes in three of the six years. A slight, but usually not significant, negative correlation of marketable yield with specific gravity was found for russet potatoes. A significant negative correlation of marketable yield with specific gravity was found in three of the six years for white potatoes. Regression analyses of marketable yield on specific gravity showed a great dispersion of values. Since only one or two advanced lines are potential variety releases, the present breeding approach is sufficient to continue to release potato varieties of acceptable yield and specific gravity.

Compendio

Cada año, los clones de papa (*Solanum tuberosum* L.) que permanecen en el programa de mejoramiento de papa después de seis o más años de selección son incorporados en ensayos de rendimiento en Maine. Los datos sobre la gravedad específica y rendimiento fueron analizados por seis años (1972, 1975, 1978, 1981, 1984 y 1987) para determinar la relación existente entre la gravedad específica y el rendimiento para poblaciones de papa de piel blanca y piel roja. En estos ensayos, los rendimientos comerciables de la papa de piel blanca fueron significativamente mayores que aquellos de la papa roja. En tres de los seis años la gravedad específica promedio fue significativamente mayor en la papa blanca que en la papa roja. Una pequeña, pero generalmente no significativa correlación negativa de rendimiento comerciable con la gravedad específica fue encontrada para

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Accepted for publication July 20, 1989.
ADDITIONAL KEY WORDS: *Solanum tuberosum*, russets, white potatoes.

la papa roja. En tres de los seis años se encontró una correlación negativa significativa del rendimiento comerciable con la gravedad específica para la papa blanca. El análisis de regresión del rendimiento comerciable sobre la gravedad específica mostró una gran dispersión de valores. Desde que solo una o dos líneas avanzadas son variedades potenciales a liberarse, el presente enfoque de mejoramiento es suficiente para continuar liberando variedades de papa de rendimiento y gravedad específica aceptables.

Introduction

Every year the potato germplasm and enhancement program at the Beltsville Agricultural Research Center, Beltsville, Maryland, produces up to 50,000 seedling tubers in the greenhouse for preliminary screening during the following year on the Chapman Farm in Presque Isle, Maine. From this initial population, up to 1,500 clones are selected based on horticultural characteristics such as tuber shape, smoothness, yield, and freedom from defects for a second year of field evaluation in 12-hill plots in Maine. Selections are made in the field based on horticultural characteristics again, specific gravity is measured, and one chipping or frying sample is evaluated following harvest. A low specific gravity measurement or chipping or frying score is used to eliminate the poorest performers. In the third, fourth, and fifth year of field evaluations for tuber characteristics, 60-hill plots are grown and the number of clones remaining for further evaluation rapidly decreases. After the sixth year, the few clones which have survived this selection procedure are entered into yield and disease trials and tested by State cooperators. Here again, the number of clones is further reduced. Each year's selection is subjected to specific gravity measurements and sample chipping or frying evaluation, and the performance is compared to the remainder of the population such that the lowest performing clones are discarded. Since 1969, 11 varieties have been released from this program using this procedure (1, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13).

Several State and industry cooperators hold the opinion that, in general, as specific gravity improves, yield decreases. Since specific gravity is associated with product yield per pound of raw product for such potato products as chips and fries, it is important to determine if the procedure presently used is sufficient to produce potential varieties with acceptable yield and specific gravity.

The purpose of this study is to determine the correlation between yield and specific gravity among the best of the USDA potato germplasm — those potential varieties which have survived the selection procedure to be included in yield trials.

Materials and Methods

Data from yield trials in 1972, 1975, 1978, 1981, 1984, and 1987 were included in this study. Breeding lines evaluated in yield trials are either dis-

carded or entered into grower trials after three years. Thus, sampling at three-year intervals ensured that a new population of potential varieties was being evaluated for each of the six years included in this study. Three standard varieties (Russet Burbank, Kennebec, and Monona) were grown in yield trials in five of the six years of evaluation.

All yield trials were planted in a randomized complete block design with four replications. White and russet potatoes were planted in different sets in the same field. Yield trials from 1972 to 1981 were evaluated on Aroostook Farm, Presque Isle, Maine and those from 1984 to 1987 at Echo Lake, Presque Isle, Maine. In 1972, 16-hill plots were planted and the number increased to 25-hill plots thereafter. Spacing was 23 cm within the row for white potatoes and 30-36 cm for russet potatoes. Rows were 91 cm apart. Plots were fertilized with 139 kg/ha N, P_2O_5, and K_2O in 1972 and 1975. From 1978 to 1987, white potato plots were fertilized with 168 kg/ha N, P_2O_5, and K_2O and russet potato plots were fertilized with 202 kg/ha N, P_2O_5, and K_2O.

Specific gravity was determined on a random sample of tubers from each plot using the weight-in-air and weight-in-water method (2).

Mean marketable yield and specific gravity were calculated for all clones of each tuber type in each year. A t-test was used to compare the population means of unequal samples (5). Correlation coefficients between clonal mean marketable yield and mean specific gravity were computed. Clonal mean marketable yield was regressed on clonal mean specific gravity for each tuber type in each year.

Results and Discussion

Mean marketable yield of white potatoes was significantly greater than that of russet potatoes at the 1% level for every year included in the study (Table 1). The mean marketable yield of the three check varieties (Table 2) showed the same general trend as those of all the advanced breeding lines. Tuber production was exceptionally good in 1972 and 1981 but not in 1975 and 1987.

The mean specific gravity of white potatoes was significantly greater than that of russet potatoes in three of the six years (Table 3).

The correlation coefficients of mean clonal marketable yield with mean clonal specific gravity were generally negative for both russet and white potatoes (Table 4). However, for the russet potatoes, only one of these correlation coefficients was significantly different from zero. Significant negative correlations of marketable yield with specific gravity were found for white potatoes in three of the six years. Although significant, these correlations are relatively low.

Mean clonal marketable yield was regressed against mean clonal specific gravity for each year by tuber type. The square of the correlation coeffi-

TABLE 1. — *Number of potato clones evaluated in replicated yield trials (N), the mean marketable yield by tuber type, and the standard error (s.e.) of the mean in each of six years.*

	Tuber Type						
	Russet			White			
Year	N	Yield (kg/ha)	s.e.	N	Yield (kg/ha)	s.e.	Yield difference
1972	16	34,690	6619	81	45,373	6819	**
1975	27	25,962	3833	67	30,763	3470	**
1978	55	27,931	5408	66	33,816	5084	**
1981	21	38,899	4997	25	43,596	5069	**
1984	27	27,371	4829	34	37,911	6293	**
1987	28	26,467	6028	83	30,242	4512	**

**Significant at the 1% level

TABLE 2. — *Mean marketable yield (kg/ha) of three potato varieties in each of five years.*

	Variety		
Year	Russet Burbank	Kennebec	Monona
1972	41,471	56,490	35,755
1975	29,142	33,065	29,142
1978	34,970	32,168	30,263
1981	48,420	36,651	40,799
1984	—	—	—
1987	22,193	34,970	26,788

TABLE 3. — *Mean specific gravity of potato clones by tuber type in each year.*

	Tuber Type		
Year	Russet	White	Specific gravity difference
1972	1.080	1.081	NS
1975	1.080	1.081	NS
1978	1.079	1.086	**
1981	1.077	1.077	NS
1984	1.080	1.086	**
1987	1.095	1.099	*

NS, *, **Nonsignificant or Significant at the 5% or 1% levels, respectively.

TABLE 4. — *Correlation coefficients of mean marketable yield with specific gravity by tuber type in each year.*

Year	Tuber Type	
	Russet	White
1972	-0.40	-0.34**
1975	-0.19	-0.06
1978	-0.16	-0.29**
1981	-0.44*	-0.39
1984	0	-0.31
1987	-0.02	-0.23*

*, **Significant at the 5% or 1% levels, respectively.

cient, also known as the coefficient of determination, (R^2), was low for each year and tuber type, indicating that there was a great deal of dispersion about the fitted regression line (Table 5).

These results indicate that the present breeding procedure produces a population of potato clones in which marketable yield and specific gravity are usually not significantly correlated for russet potatoes. Despite the significant negative correlation of mean marketable yield and specific gravity in three of the six years within the population of white potatoes, the large dispersion of genotypes over the two traits measured assures that there will be an adequate number of clones available from which to select for acceptable yield and specific gravity.

TABLE 5. — *Square of the correlation coefficients from the regressions of mean clonal marketable yield on mean clonal specific gravity by tuber type in each year.*

Year	Tuber Type	
	Russet	White
1972	0.16	0.12
1975	0.04	0
1978	0.02	0.04
1981	0.19	0.15
1984	0	0.10
1987	0	0.05

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